

THE CLAIMS

What is Claimed is:

1. A method of controlling copper electrochemical deposition in an electrochemical deposition system in which a wafer is contacted with an electrochemical deposition medium including at least one organic additive, wherein the electrochemical deposition medium has a plating anode in contact therewith to effect plating of copper on the wafer, and the electrochemical deposition is characterizable by at least one dependent variable correlative of efficacy of the copper electrochemical deposition, said method comprising:

selecting at least one dependent variable correlative of efficacy of the copper electrochemical deposition;

performing a regression analysis or multivariate calibration modeling of the copper electrochemical deposition utilizing a wafer-based independent variable to generate a dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition;

solving the dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition, by regression analysis, to yield a solution value for each selected dependent variable; and

modulating the copper electrochemical deposition in response to the solution value for each selected dependent variable.

2. The method of claim 1, wherein the wafer-based independent variable is selected from the group consisting of plating voltage output, plating current, electrode size, and wafer preconditioning pulse.

3. The method of claim 1, wherein the electrochemical deposition medium includes a copper salt and an inorganic acid.

4. The method of claim 3, wherein the inorganic acid comprises sulfuric acid.
5. The method of claim 3, wherein the copper salt comprises copper sulfate.
6. The method of claim 1, wherein the at least one organic additive includes an organic additive selected from the group consisting of organic accelerators, organic suppressors and organic levelers.
7. The method of claim 6, wherein the at least one organic additive includes an organic accelerator, and organic suppressor and an organic leveler.
8. The method of claim 1, wherein the electrochemical deposition medium further includes a chloride source.
9. The method of claim 1, wherein the selected at least one dependent variable includes concentration of at least one component of the electrochemical deposition medium.
10. The method of claim 9, wherein the selected at least one dependent variable includes concentration of an organic additive of the electrochemical deposition medium.
11. The method of claim 9, wherein the selected at least one dependent variable includes concentration of each organic additive in the electrochemical deposition medium.
12. The method of claim 9, wherein the selected at least one dependent variable includes concentration of at least one organic additive in the electrochemical deposition medium.

13. The method of claim 7, wherein the selected at least one dependent variable includes concentration of each organic accelerator, and organic suppressor and an organic leveler.

14. Apparatus for controlling copper electrochemical deposition in an electrochemical deposition system in which a wafer is contacted with an electrochemical deposition medium including at least one organic additive, wherein the electrochemical deposition medium has a plating anode in contact therewith to effect plating of copper on the wafer, and the electrochemical deposition is characterizable by at least one dependent variable correlative of efficacy of the copper electrochemical deposition, said apparatus comprising:

a computational module constructed and arranged to perform the following steps:

selecting at least one dependent variable correlative of efficacy of the copper electrochemical deposition;

performing a regression analysis or multivariate calibration modeling of the copper electrochemical deposition utilizing a wafer-based independent variable to generate a dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition; and

solving the dependent variable equation for each selected dependent variable correlative of efficacy of the copper electrochemical deposition, by regression analysis, to yield a solution value for each selected dependent variable; and

means for modulating the copper electrochemical deposition in response to the solution value for each selected dependent variable.

15. Apparatus according to claim 14, wherein the wafer-based independent variable is selected from the group consisting of plating voltage output, plating current, electrode size, and wafer preconditioning pulse.

16. Apparatus according to claim 14, wherein the electrochemical deposition medium includes a copper salt and an inorganic acid.
17. Apparatus according to claim 16, wherein the inorganic acid comprises sulfuric acid.
18. Apparatus according to claim 16, wherein the copper salt comprises copper sulfate.
19. Apparatus according to claim 14, wherein the at least one organic additive includes an organic additive selected from the group consisting of organic accelerators, organic suppressors and organic levelers.
20. Apparatus according to claim 19, wherein the at least one organic additive includes an organic accelerator, and organic suppressor and an organic leveler.
21. Apparatus according to claim 14, wherein the electrochemical deposition medium further includes a chloride source.
22. Apparatus according to claim 14, wherein the selected at least one dependent variable includes concentration of at least one component of the electrochemical deposition medium.
23. Apparatus according to claim 22, wherein the selected at least one dependent variable includes concentration of an organic additive of the electrochemical deposition medium.
24. Apparatus according to claim 22, wherein the selected at least one dependent variable includes concentration of each organic additive in the electrochemical deposition medium.

25. Apparatus according to claim 22, wherein the selected at least one dependent variable includes concentration of at least one organic additive in the electrochemical deposition medium.

26. Apparatus according to claim 20, wherein the selected at least one dependent variable includes concentration of each organic accelerator, and organic suppressor and an organic leveler.

27. Apparatus according to claim 20, wherein said means for modulating the copper electrochemical deposition in response to the solution value for each selected dependent variable, comprise a means selected from the group consisting of: variable output power supplies arranged to supply power to the electrochemical deposition system; and variable flow control valves for modulating flow to the electrochemical deposition medium of one or more components of the electrochemical deposition medium.

28. Apparatus according to claim 27, wherein said modulating means comprises a variable output power supply arranged to supply power to the electrochemical deposition system.

29. Apparatus according to claim 27, wherein said modulating means comprises variable flow control valves for modulating flow to the electrochemical deposition medium of one or more components of the electrochemical deposition medium.

30. Apparatus according to claim 29, wherein the variable flow control valves are respectively coupled with sources of accelerator, leveler and suppressor.